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ABSTRACT

Although some aspects of the educational effects of computer assisted instruction (CAI) are still unclear, some research findings are now quite definite. Two meta-analysis reviews of CAI have been completed at the University of Michigan, one on secondary school teaching and one on college teaching, and their findings have been independently verified by independent meta-analyses. Conclusions are that CAI (1) has real potential as a tool in improving student achievement in precollege classes; (2) fosters positive attitudes toward the computer; and (3) can produce substantial savings in instructional time. Findings on CAI outcomes are very robust, with differences in instructional environments, samples of students used, and methodological designs of studies having no substantial effects on outcomes of CAI and conventional teaching. The effectiveness of CAI may be limited by its use as a complete replacement for conventional instruction and enhanced by the use of up-to-date programs and computers. A safe conclusion is that the computer can be used to help learners become better readers, calculators, writers, and problem solvers. Six references are listed. (LMM)

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Effects of Computer-Based Teaching on Learners

by

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Presentation at the Symposium on
Computer Competency and the Curriculum
National Forum of the College Board
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During the last two decades, computer technology has changed the way teachers do research. During the current decade, it is changing the way they compose articles and books. During the next decade, it will also change the way they teach. The microcomputers, computer communication systems, computer-controlled videodiscs, and other electronic marvels that are now entering the classroom may alter forever the methods that we use to pass on knowledge and skills to future generations.

The Carnegie Commission on Higher Education in 1972 predicted this revolution in teaching methods. The Commission members that that it would rival in importance three earlier educational revolutions, and they labelled it the "fourth revolution." According to the Commission, the first educational revolution came when societies began to differentiate adult roles and shifted the task of educating the young from parents to teachers and from the home to the school. The second revolution occurred with the adoption of the written word as a tool of education. And the third came with the invention of printing and the subsequent wide availability of books. The Carnegie Commission thus considered the computer to be as significant an invention for education as were schools, teachers, writing, and books.

At the time, many people thought that the Carnegie Commission was guilty of rhetorical excess. Today, there are not so many scoffers. The invention of the microcomputer chip has changed things. It guarantees that

computing will have an impact on nearly every sector of society, and it may in fact make these watershed years in human history. Although only a few years ago our era was commonly thought of as the atomic age, the likelihood is growing that it will be remembered by future generations as the computer age. Education is not likely to escape the imprint that the computer is leaving on our times.

It seems safe to predict that children in the future will learn with computer help throughout the school years. In the elementary grades, they will work on drill-and-practice exercises at computer stations, and they will also use programming languages such as LOGO as discovery tools in the early school years. Later, they will receive tutorial instruction at computer stations; they will compose essays using word-processing programs; they will analyze data on the computer; and they will explore models of physical and social reality using computer simulations. Although computers will never replace human beings as teachers, they will nevertheless become indispensable tools in teaching.

What impact will all this have on learners? For more than two decades now, educational evaluators have been trying to assess the effects on students of computer technology. And reviewers -- like myself -- have been trying to synthesize their findings into a coherent picture. Although a few aspects of this picture are still unclear, some findings are now pretty definite. I will speak this morning about these well-established findings because I

think that they have implications for developing computer literacy in our students.

Systematic comparisons of computer-based and conventional teaching first began to appear in print in the late 1960s. In a typical evaluation study, a researcher divided a class of students into an experimental and a control group. Members of the experimental group received part of their instruction at computer terminals, whereas students in the control group received their instruction by conventional teaching methods. At the end of the experiment, the researcher compared responses of the two groups on a common examination or on a course evaluation form. Researchers carried out more than 150 such studies during the 1960s and 1970s.

It is hard to bring the results of these studies into focus in a traditional narrative or box-score review. The studies are simply too numerous for adequate treatment in narrative form. And their findings are too rich to be summarized adequately in a simple box-score tally of studies favorable and unfavorable to computer-based instruction.

My colleagues and I have therefore taken a different approach in integrating the findings from these studies. We used a newly developed technique called "meta-analysis." The psychologist Gene Glass first described the use of this technique in his 1976 presidential address to the American Educational Research Association. By meta-analysis, Glass simply meant the analysis of analyses, or the statistical

analysis of a large collection of results from individual studies for the purpose of integrating the findings. Researchers who carry out a meta-analysis first locate studies of an issue by clearly specified procedures. They then characterize the outcomes of all studies on a common scale of effect size and describe study features in categorical or quasi-quantitative terms. Finally, meta-analysts use multivariate techniques to describe findings and relate characteristics of studies to study outcomes.

My colleagues at the University of Michigan and I recently completed two meta-analytic reviews of findings on computer-based instruction -- one on secondary school teaching and one on college teaching -- and we are currently finishing a third on elementary school instruction (Kulik, Bangert, & Williams, 1983; Kulik, Kulik, & Cohen, 1979). We are not the only ones, however, to have conducted meta-analytic reviews on computer-based teaching. Another meta-analytic review was produced recently by a researcher at the University of Colorado (Hartley, 1978) and still another was done at the University of Iowa (Burns & Bozeman, 1981). The findings I will report therefore have been independently verified in several meta-analyses.

The meta-analyses showed, first of all, that computer-based instruction has real potential as a tool in improving student achievement in precollege classes. The average effect of computer-based teaching in such classes was to raise student achievement by approximately .4 standard

deviations, or from the 50th percentile to the 66th percentile. This compares favorably to the effects produced by other instructional technologies. Programmed instruction and individualized instruction, for example, raised student achievement in precollege classes by only .1 standard deviations.

Our second major conclusion was that computer-based teaching fostered positive attitudes toward the computer. Students who learned with computer assistance developed far more favorable attitudes toward computers than did students who received all their instruction by conventional means. Use of the computer in instruction may therefore help prepare students for the computer society in which they will live and work. With more than half of all workers projected to be using computers in their jobs by the end of this century, the effects of computer-based teaching on attitudes toward computers are of great potential importance.

Our third major conclusion was that computer-based instruction can produce substantial savings in instructional time. Several studies showed that students can learn more quickly with computer assistance than with conventional teaching methods. Although the claim of quicker learning has also been made for programmed instruction, findings for computer-based teaching are far more dramatic than are findings for programmed instruction. This time-saving effect of computer-based teaching is potentially as important as are its effects on student achievement.

Our fourth major conclusion was that findings on computer-based instruction outcomes are very robust. Differences in instructional environments, samples of students used, and methodological designs of studies had no substantial effects on outcomes of computer-based and conventional teaching. I would place only limits on the generality of conclusions about computer-based instruction, and even these restrictions are tentative because the relevant factors have been examined in very few studies.

One thing that may limit the effectiveness of computer-based instruction is its use as a complete replacement for conventional instruction. Computer-based instruction is not often studied in this way but the few studies where the computer provides all the instruction show unimpressive findings. Total reliance on the computer as teacher seems to be one thing schools should avoid. The effectiveness of computer-based instruction appears to be enhanced, on the other hand, by the use of up-to-date programs and computers. In studies carried out during the period from 1976 to 1980, when more sophisticated software and hardware were available, achievement gains were almost twice as large as were those in earlier studies. This gives us reason to hope that even greater gains can be achieved with the programming inventiveness of the future.

A safe conclusion to draw from the accumulated evaluation evidence, therefore, is that the computer can be used to help learners become better readers, better

calculators, better writers, and better problem solvers. A side benefit for students who learn with computer assistance is the development of an appreciation of the usefulness of computers as tools. For such students, computers lose their status as toys for the hobbyist or as the special instrument of the computer "hacker." Students come to appreciate computers for what they are. They develop "computer literacy" while developing literacy in the traditional sense.

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